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Large Scale Production of Hydrogen Using Nuclear Reactors

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ABSTRACT

The sulfur iodine (SI) cycle offers much potential for the large-scale production of hydrogen via nuclear reactors. Just recently, semi-scale experiments showed the capacity for the production of ~200 liters/hr of hydrogen. In the area of computer simulations, researchers have analyzed the SI cycle by using steady-state process flow sheets such as ASPEN. However, to date, neither transient behavior of SI cycles nor the dynamic simulation of an SI cycle that is fully coupled with a nuclear reactor and its associated secondary system, has been modeled. Such modeling is important, as current research shows that there is a complex, dynamic interdependent behavior of the subsystems, and this affects hydrogen and electrical output, safety, and overall plant behavior.

To that effect, we developed a tool called MELCOR-H2, which includes the following models: nuclear reactor, SI chemistry, secondary system components, and a graphical user interface. The chemistry model includes the three major SI chemistry sections (sulfuric and hydriodic acid decomposition, and the Bunsen reaction). The nuclear reactor model can simulate prismatic and pebble bed gas cooled reactors. It also includes point kinetics and intermediate heat exchanger (IHX) models for coupling to the secondary system. The secondary system model simulates turbines, compressors, heat exchangers, and generators.

MELCOR-H2 analysis shows that each plant can produce about 300 million kilograms of hydrogen/year and generate close to 390 MW of electricity. This is the energetic equivalent of 378 million gallons of gasoline. Recently, MELCOR-H2 was used to simulate sulfuric acid experiments conducted at SNL.

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